

Impact of COVID-19 Lockdown on the Shear Wave Speed of Professional Football Players Hamstring Muscles

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ABSTRACT

AIM: This work aims to evaluate the impact of COVID-19 lockdown on the shear wave speed (SWS) of hamstrings muscles of professional football players from the Spanish National Football League.

MATERIALS AND METHODS: Shear wave elastography examinations were performed on five elite football players' hamstrings both before and after COVID-19 lockdown in two positions: a slack position and a tense position. The B-mode ultrasound technique was used to detect fibre disruption or unusual echogenicity in hamstring muscles' areas with previous injury

RESULTS: A statistically significant increase of SWS was found in the biceps femoris (BF) in the right leg (dominant leg for most

players) in both of positions, but no significant difference was found in the other muscles. In the slack position, the BF shear wave speed showed a median increase of 1.64(1.15-1.88) and 1.35(1.25-2.82) folds in the superficial and deep proximal-mid third, respectively. In the tense position, the only statistically significant difference in shear wave speed before and after the COVID-19 lockdown was found in the deep proximal-mid third of BF in the right leg. The BF shear wave speed showed a median increase of 2(1.74-2.43) folds in the deep proximal-mid third in the tense position. There were no statistically significant differences in the number of injuries per football player before and after the COVID-19 lockdown

CONCLUSION: This is the first study to report that a temporary interruption of physical exertion by football players can decrease the stiffness of the BF, which could reduce the number of hamstrings injuries.

Key words: COVID-19; Football; Hamstrings; Shear wave elastography

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INTRODUCTION

In 2019, COVID-19, a new viral respiratory disease, emerged in Wuhan (Hubei province, China), and became a pandemic^[1] we provide a preliminary evolutionary and molecular epidemiological analysis of this new virus. A phylogenetic tree has been built using the 15 available whole genome sequences of 2019-nCoV, 12 whole genome sequences of 2019-nCoV, and 12 highly similar whole genome sequences available in gene bank (five from the severe acute respiratory syndrome, two from Middle East respiratory syndrome, and five from bat SARS-like coronavirus. The most common symptoms include fever, dry cough and fatigue, though the disease may lead to severe symptoms like difficulty breathing or shortness of breath, chest pain or pressure and loss of speech or movement^[2]. The

COVID-19 pandemic is already considered one of the most critical global health crises since the Second World War^[3].

The main approach to control the pandemic involved the adoption of strict rules to use of personal protective measures and increase social distancing through the ‘lockdown’^[4]. This lockdown rapidly modified daily life, disrupted world trade and movements^[5] and gave rise to physical, psychological, and behavioural consequences in all individuals^[6,7]. Further, it impaired the regular training routines of athletes around the world and damaged the quality and quantity of training^[7,8]. In Spain, for example, all professional football competitions were suspended by Royal Decree 664/1997 as of 12 May 2020, after the conclusion of Matchday 24, leaving 14 matches left for the conclusion of the 2019-2020 season. During the 56 days of lockdown, professional football players were unable to train at the professional facilities used during their normal play seasons. This unusual situation has provided an opportunity to evaluate the training reversibility or detraining that takes place when football players are forced to stop training^[8].

The hamstring muscles, consisting of the semitendinosus (ST), semimembranosus (SM), and biceps femoris (BF) muscles, generate hip extension and knee flexion, and so play an important role in acceleration capacity^[9] RTD. The strain of these muscles is one of the most frequent and recurrent injuries in sports and result in a considerable time lost from training and competition^[10].

Shear wave elastography (SWE), a kind of ultrasound-based technology, is fast, non-invasive and easy-to-use^[11]. In brief, this technology is based on estimating shear wave propagation speed. For that, a probe generates a radiation force in tissue which creates a shear wave, which in turn propagates and is captured by taking consecutive ultrasound images at a high repetition frequency^[11-13]. SWE can provide real-time qualitative data and quantitative data of the elasticity in the selected regions^[11,14], such as musculoskeletal soft tissues, including tendons, muscles, nerves, and ligaments^[15]. SWE also provides complementary information to conventional ultrasound by adding the parameter of stiffness, which is an important factor in physical function, movement execution and performance in sport^[11]. This work aims to evaluate the impact of COVID-19 lockdown on the shear-wave speed of hamstrings muscles of professional football players from the Spanish National Football League.

MATERIALS AND METHODS

Five healthy football players from the Spanish National Football League with a median age of 27 (27-30) years; a median height of 188 (188-189) cm; and a median body mass of 83 (77.8-86) kg voluntarily participated in the study. For four players, the dominant leg is the right one. To be included in the study, participants had to be free from lower limb injuries, hamstring injuries or any neuromuscular problem at that moment of the study. Furthermore, participants were instructed not to perform strength or flexibility training 24 hours before the study testing session. Before each test session, participants were informed about the aims and procedures of the study and were required to sign an informed consent form to participate. The study was approved by the Medical Ethics Committee at University Clinic of Navarra.

A diagnostic ultrasound system, the LOGIQ S8 XDclear (GE Healthcare, USA), in SWE mode was used for all measurements. Muscle stiffness was assessed by acquiring shear wave speed (m/s) data. The ultrasound system was set to musculoskeletal SWE mode (assuming tissue density of 1,000 kg/m³). A multifrequency linear probe (2-10 MHz) (GE Healthcare, USA) covered with a sterile

sleeve and coated with a 5-mm thick layer water-soluble, hypoallergenic ultrasound gel (Quick-Eco gel, Lassa, Spain) was used. The size of the region of interest (ROI) was set to 1-cm radius. The depth of the region of interest was chosen based on the participants’ anthropometric characteristics, at the middle third of the thigh superficially and deeper than 1 cm to avoid superficial myofascial small injuries. All measurements were taken by a radiologist experienced in the probe positioning and discerning the different anatomical structures of the musculoskeletal system of the lower limb.

In this study, SWE was combined with B-mode imaging to increase the ultrasound arsenal for the characterization of hamstrings muscles^[16] before and after COVID-19 lockdown. The SWE technique was performed according to the methodology previously described^[15]. Briefly, participants were examined in two supine positions: the slack position, with a 90-degree hip flexion and 90-degree knee flexion (Figure 1a), and the tense position, with a 90-degree hip flexion with a knee extension to mimic the powerful hamstring contraction that often causes injury (Figure 1b). The flexion angles were always measured with a digital Absolute+Axis™ goniometer (Baseline Evaluation Instruments, USA). The probe was placed on the hamstring muscles according to the same protocol previously explained. To avoid deep measurement variations, it is recommended to place the ulnar aspect of the operator’s hand on the skin surface to control the applied force. The preferred view is longitudinal, 45° to muscle fibres. A quantitative colour map was given by the ultrasound software. Afterwards, the BF, the ST and the SM of shear wave speed were calculated for each muscle in both positions. The hamstring muscles were scanned following the sonographic landmarks previously described in these muscles^[17]. The medial distal half, corresponding to the SM muscle and ST muscle, over there the SM muscle mass is much larger than SM using as a landmark (Figure 2A). The lateral distal half, corresponding to the BF, is examined using the head of the fibula as a landmark (Figure 2B). At the proximal-mid thigh, corresponding to the SM, ST and BF muscles, the landmarks are the sciatic nerve and the ST^[18].

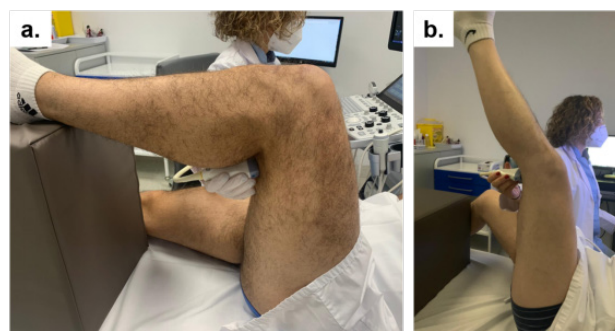


Figure 1 The slack position (A), and the tense position (B).

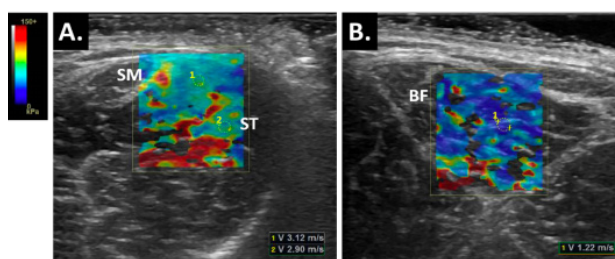


Figure 2 Representative ultrasound shear wave elastographic images of (A) semimembranosus (SM), semitendinosus (ST), and (B) biceps femoris (BF) and their shear wave speed (V) from each ROI (yellow circle).

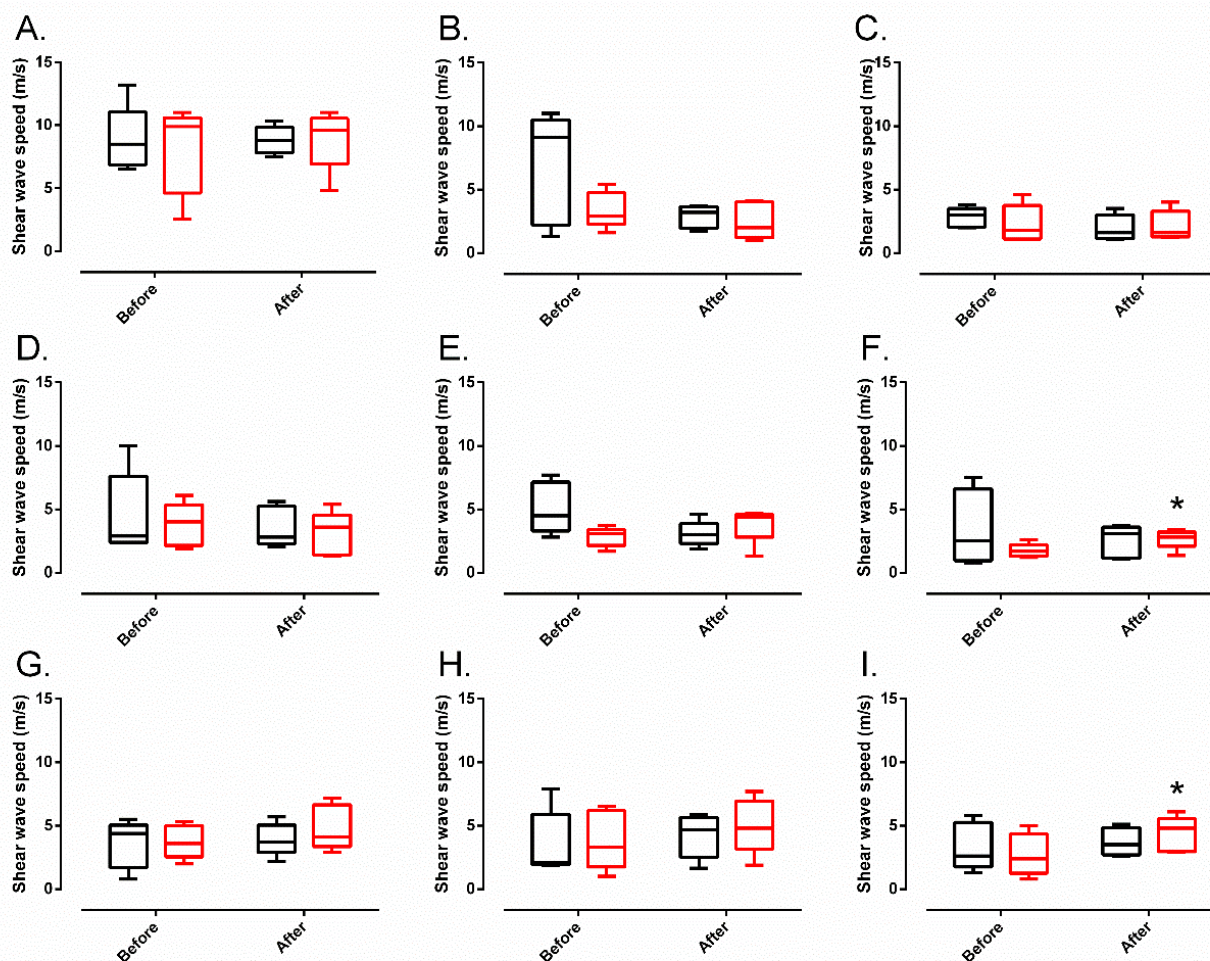


Figure 3 Shear wave speeds from the medial distal half (a-c) and the superficial (d-f) and deep (g-i) proximal-mid third of the ST (left column), SM (middle column), and BF (right column) of the left (black) and right (red) leg in the slack position before and after the COVID-19 lockdown. *: $p < 0.05$ for the Wilcoxon test between each leg before and after the COVID-19 lockdown.

Furthermore, two measurements from different depths (superficial and deep ROI) were taken for the proximal-mid third due to the common tendon of hamstring muscles conformed by the BF long head and the ST that is the most common musculoskeletal injury site in football players^[19].

The B- mode ultrasound technique was used to detect fibre disruption or unusual echogenicity in hamstring muscles' areas with previous injury, defined as an incident during a scheduled match that caused the football player to miss the next match or a practice session^[20].

Statistical analyses were performed using Stata statistical software, Release 11 (StataCorp 2009). A one-tailed Wilcoxon paired test was used to compare the differences between shear wave speed of each hamstrings muscle before and after COVID-19 lockdown. Statistical significance was set at $p < 0.05$. Values are provided as median and interquartile range.

RESULTS

The shear wave speeds obtained for each of the three hamstring muscles in both positions A and B are shown in Figure 3 and 4, respectively. In the slack position, statistically significant differences in shear wave speed before and after the COVID-19 lockdown were found in the superficial (Figure 3F) and deep (Figure 3I) proximal-mid third of BF from the right leg ($p = 0.0313$ for each). The BF shear wave speed showed a median increase of 1.64 (1.15-1.88) and

1.35 (1.25-2.82) folds in the superficial and deep proximal-mid third, respectively. In the tense position, the only statistically significant difference in shear wave speed before and after the COVID-19 lockdown was found in the deep proximal-mid third of BF in the right leg ($p=0.0313$) (Figure 4I). The biceps femoris shear wave speed showed a median increase of 2(1.74-2.43) folds in the deep proximal-mid third in the tense position.

The median number of injuries per football player was 1(0-1) before and 0 (0-0) after the COVID-19 lockdown. There were no statistically significant differences in the number of injuries per football player before and after the COVID-19 lockdown ($p = 0.2500$).

DISCUSSION

The current study is, to our knowledge, the first that evaluates the differences of the shear wave speed of the individual hamstring muscles (semitendinosus, semimembranosus, and biceps femoris) of elite football players before and after the COVID-19 lockdown. The results of this study show that the COVID-19 lockdown may have altered the elasticity of at least one of the three hamstring muscles.

COVID-19 lockdown has led to a detraining of football players, involving a partial/complete loss of previous physiological adaptation skills^[21]. This detraining can cause changes in body mass and composition, loss of efficiency of neuromuscular and cardiovascular systems and, consequently, loss in strength, speed, flexibility and

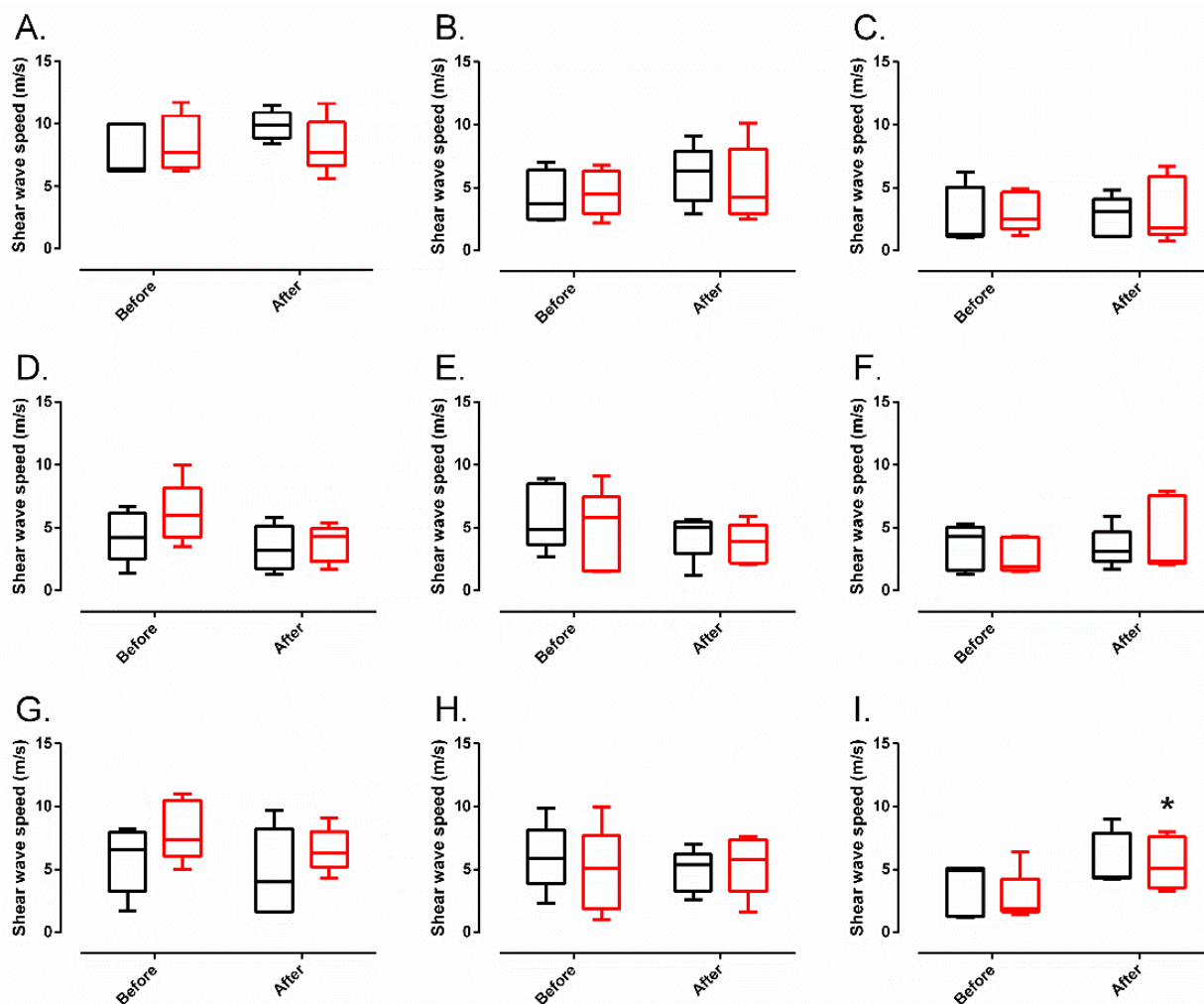


Figure 4 Shear wave speeds from the medial distal half (a-c) and the superficial (d-f) and deep (g-i) proximal-mid third of the ST (left column), SM (middle column), and BF (right column) of the left (black) and right (red) leg in the tense position on the table with a 90° hip flexion and knee extension before and after the COVID-19 lockdown. *: $p < 0.05$ for the Wilcoxon test between each leg before and after the COVID-19 lockdown.

endurance as well as an increase of the risk of injury^[22]. Nevertheless, our results show that the COVID-19 lockdown decreased the stiffness of the biceps femoris of the hamstring muscles in the right leg. Previous studies have pointed out that strains usually take place in the biceps femoris of the hamstring muscles and that the most common location for injury is near the muscle-tendon junction^[20,23-26]. It is known that the lower the hamstring stiffness, the lower the frequency of lower extremity overuse injury^[27]. Hence, our results suggest that, due to reduced stiffness in the football players' biceps femoris, there are potential benefits to a temporary interruption in football league play. The stiffness decrease was clearly associated with the preferred limb of most of the football players, the right for four of the five participants. These findings are in agreement with other authors who took into account the preferred limb for study^[10,28-30].

Most studies of footballers suggest that hamstring strains occur during the latter part of the swing phase while players are running or sprinting, as the hamstrings work to decelerate knee extension^[20]. The hamstrings have to switch from working eccentrically, to decelerate knee extension in the final phase of the swing, to concentrically, acting as an active extensor of the hip joint^[24]. The muscle is therefore more vulnerable to injury at this shift^[25]. In this study, although the biceps femoris shear wave speed increased in two of three locations (the superficial and deep proximal-mid third) in slack position where the hamstrings are more relaxed, the highest and most conspicuous

increase in shear wave speed was detected in the deep proximal-mid third in the position which mimics the powerful eccentric contraction of hamstrings where they are more vulnerable to injury. This finding suggests a protective effect of the COVID-19 lockdown on the biceps femoris of elite football players.

This study is not exempt from some limitations. As the number of participants was low, a larger-scale study is needed to corroborate our findings. Because all participants here are men, there is a gender bias. Further studies should include both men and women. Additionally, the shear wave speed of each hamstring muscle was only measured in passive positions without contraction. Therefore, further studies are needed to compare the shear wave speed of each muscle contracted and non-contracted. Finally, all measurements were taken by a single radiologist; there was no comparison between observers.

CONCLUSIONS

Our results suggest that a temporary interruption in the physical activity of football players, such as that caused by the COVID-19 lockdown, can decrease the stiffness of the biceps femoris, leading to a possible reduction of the number of hamstrings injuries.

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